THE NEED FOR INVESTIGATING FISH CONDITIONS IN WINTER

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This paper applies primarily to those regions where ice covers most standing waters for a considerable period. The purpose of the paper is to emphasize the need for investigating freshwater fish conditions in winter to the end that the annual fish crop may be increased. This line of fisheries investigation, though often recognized as a need, has seldom been carried out.

I.

An analysis of the need for winter investigations and of the part these should play in fisheries work, calls for a review and interpretation of inland fisheries research during the past fifteen years. Fisheries studies throughout this period have been connected with the four primary means of increasing the fish crop, namely: (1) stocking hatchery-reared fish, or introducing exotic species; (2) protecting the natural brood stock reserve by the enactment of laws restricting the taking of fish, and by the enforcement of these laws; (3) preventing waters from becoming (or remaining) unsuited, through pollution, to the desired food and game fishes; (4) creating more favorable conditions for the support of these valued forms of fish life.

During these past fifteen years, as in many previous periods, the propagation and distribution of fish have been made more efficient by application of scientific principles, and the various fish species are being planted in ever increasing numbers. The definite trend away from the planting of fry and small fingerlings, toward the stocking of larger fingerlings, half-grown and even adult fish, has been in general validated and in part prompted by pertinent investigations (unfortunately too few). Sustaining the yield of game fishes, where the species already occur, and establishing species where they are absent, has been placed on a more effective and economical basis by numerous stream and lake surveys.

The continued efforts of the various states and the federal government to increase the protection of fishes from overfishing and from law violators have been aided, and in part suggested, by investigations of fish biology. These studies have shown what sort of protection is needed, and analyses of the catch have tested the effectiveness or failure of various restrictive measures now in force or contemplated.

The real progress made during the last fifteen years in lessening the harmful pollution of natural waters has been greatly assisted by re-

search. The amount of harm done to fish life, and to other aquatic resources and recreational values, has often been determined. The whole difficult problem has been clarified by showing that after proper treatment, sewage of certain types is not only harmless, but actually beneficial to fish life. The multiple effects of toxic wastes on fishes have frequently been indicated in field and laboratory studies. The treatment of wastes to destroy their toxicity has been made possible by the researches of chemical engineers and by fishery investigators, who have determined the toxicity threshold of the wastes.

The organization of the newest field of fishery work, stream and lake improvement, has been a direct outcome of stream and lake surveys. Repeated indications of poor production of food and game fish in certain streams and lakes, or in certain sections thereof, naturally led to the search for remedial measures. Ecological observations of general conditions prevailing where fish abound, and of the specific environmental features providing good shelter, abundant food and suitable spawning conditions, called to mind that these obviously favorable conditions were often lacking or inadequately present in the waters yielding a poor fish crop. Preliminary experimental improvement work indicated the practicability of supplying these lacking or deficient conditions and increasing the fish production through this form of modification of the physical features of the environment.

Studies of hydraulics and engineering principles have aided in developing long-lasting and efficient improvement devices. Careful records have shown that the physical environment has been improved, for example, by digging out holes in the stream bed. Biological tests have indicated that shelter, spawning and food conditions have all been bettered in both streams and lakes, and that fish production can be increased well toward the limit imposed by the basic fertility of the water. Expectations that even this natural limitation to fish production may be overcome are based chiefly on the long-continued and extensive scientific investigations by Birge and Juday on the biological productivity of Wisconsin lakes, and on the possibilities of increasing the natural fish crop through fertilization of the water. Additional research is required to determine the amount of benefit obtainable from the use of the various methods of lake and stream improvement, and it is particularly in this new field that winter investigations are needed.

II.

In reviewing inland fishery research over the past 15 year period, we note that the investigations have been confined almost wholly to the warmer months. The investigators who have busied themselves with field work in summers have come indoors over the winter, to carry on laboratory work in fisheries, to write up the results of their summer field work or to engage in teaching or some other line of work not directly connected with the fisheries.

Almost no real effort has been made to determine how seriously the

winter conditions in different waters affect fall or winter plantings of fry, fingerlings or adults, or how unfit these waters are rendered by unfavorable winter conditions for each game fish species. A bare beginning has been made in determining the mortality in trout eggs and alevins in the gravel over winter. Until such studies are completed, it will be impossible to compare intelligently the effects of artificial and natural reproduction, or to determine the relative advantages of planting fish the previous fall or during the fishing season. Learning where fingerling fish naturally live during the winter should aid in selecting effective sites for winter plantings.

Only during the last three or four years has any considerable effort been made to determine the amount of depletion suffered by the game fishes through winter fishing. Local residents and resorters have grown hot, with arguments as to the proportion of pike caught through the ice, yet little effort has been made to get at the facts. In another talk on this program, Mr. Eschmeyer discusses the complete creel censuses being taken in winter as well as summer in some Michigan lakes. The survival ratios and change in weight of fishes over winter, vital to the determination of the most satisfactory open seasons, have remained largely undetermined.

Wise and effective regulations for the control of certain predators can hardly be enacted without knowledge of their winter activities. Animals not often considered predators may prove destructive in winter, for example, ciscoes, which in summer subsist on plankton or on minute bottom organisms in deep water, in winter feed to a large but not accurately determined degree on young bluegills. Mergansers are suspected of being the most serious winter predators in many trout streams, especially during severe winters when the freezing of the Great Lakes drives these fish-eating birds into the open trout streams. Some evidence suggests that these ducks may be a prime factor in depleting the trout supply, but the whole problem needs a more critical and extensive investigation, to determine not only the extent of harm done but also the most effective means for controlling the predation, should the need for control be indicated. To avoid a controversy, mention may be made of the undetermined loss of trout or of trout food down the gullets of otters, which feed all winter.

With some commendable exceptions, pollution surveys have been confined to the warmer seasons, even though conditions may become worse under the ice than in open waters. This condition often holds true even when the sewage involved is not discharged in winter, for sludge accumulated on the bottom, from the discharges of summer and fall, as from sugar plants, continues to decompose over winter. What may be termed natural pollution, in waters unusually rich in organic matter, also tends to be most destructive in winter, but the effects, even when extreme enough to cause "winter kill," have ordinarily passed by without investigation. The mortality that takes place under the ice or along with the spring breakup, may remove many

more fish than are planted in a lake. Determinations of the cause of death, whether lack of oxygen, accumulation of toxic substances, disease, or starvation should lead eventually to means for avoiding or compensating for such losses.

The investigations, surveys and even casual examinations, on which stream and lake improvement work have been based, have generally been conducted solely during the warmer months. Recent observations in Michigan have strongly confirmed our previous supposition that such field researches should be extended to include the winter months. Particular needs for winter field work in connection with lake and stream improvement, that have thus been brought to our attention, may be emphasized in query form:

May not mapping, sounding and determination of bottom soils of inland waters be most efficiently done on or through the ice?

Do the weed beds remain in thick enough stands over winter to provide adequate shelter for young and half-grown game fish?

Are brush shelters attractive to fish in winter, as well as in summer?

Where should shelters be installed to provide effective cover in winter?

Does a serious food shortage arise in winter? (Trout, pike, pike perch, perch and other fishes feed more or less actively over the winter.)

If such shortage exists, is there any practicable means of supplying the deficiency?

How seriously does the ice harm improvement devices?

Does the surface ice, which forms in quantity in most trout streams in subzero weather, lift up deflectors and covers?

How can the improvement devices be constructed to prevent loss or harm by ice action?

Does the ice-shove in lakes destroy or displace shallow-water weed beds, shelters, spawning beds, minnow spawning slabs?

How extensively does the anchor ice, which forms freely on the bottom of trout streams in very cold periods, carry off gravel from good spawning beds?

How much trout food is destroyed by this action of anchor ice?

Does much harm (or good) result from the gouging of the stream bed by upturned cakes of ice?

What effect on newly hatched trout fry, and on the older fish, and on fish food, has the moving along of masses of ice that almost fill the stream? The forming of ice jams and the subsequent scouring of the stream beds by floods?

To what extent are ice jams (likewise log jams) produced by stream improvement devices which constrict the current?

May not the ice have a more serious effect on the trout than low water stages and high summer temperatures?

Do current-speeding stream improvement devices, such as deflectors, retard or increase the formation of anchor ice?

Do deflectors, dams and covers increase the formation of surface ice in their lee? If so, what effect does this have on the formation of anchor ice, and on the fish life?

Can harm to improvement devices in lakes be avoided by raising or lowering the water level over winter?

What other effects would the changed level have?

How seriously do smallmouth bass streams (for example) flood in winter?

What effect does the high water, with the speeding of the current and the shifting of the stream bottom, have on the semi-hibernating bass?

What practicable means can be devised to lessen the winter flooding?

Do fish work out of lakes in winter, or down streams, perhaps over dams which they can not again surmount, or upstream into spring feeders?

Is it desirable to provide conditions which will cause the fish to refrain from such movements?

If so, what sort of holes or shelters will prove effective in retarding the movements?

In any event, where and how may winter conditions in streams and lakes be made most conducive to the survival of the desired species over the winter?

III.

There are several obvious reasons why winter investigations in the field of fresh-water fisheries have been so seriously neglected. Foremost among these reasons perhaps have been those involved in the question of available personnel: the insufficient supply of trained fisheries investigators, and the availability, over their summer vacation of university and college instructors and graduate students, whose training or experience more or less thoroughly qualifies them as substitutes for full-time technical staff members. Related reasons are the apparent economy of employing the university men for summers only; or the lack of sufficient funds to engage a technical staff on full-time basis; the unwillingness of conservation officials to sacrifice fish funds from hatchery operations for research work at any time, or their failure to appreciate the importance of scientific work. Happily these blocks to fisheries research work in general are being broken down in the more progressive states.

Another important reason why the investigations have largely been confined to the summer is that most interested anglers see their favorite waters only in the warmer seasons, when such critical factors as low water, high temperatures and overfishing naturally impress them, and prompt them to call for investigations. Most research workers and conservation officials themselves have seen so few lakes and streams in mid-winter that they have scarcely appreciated the stress of winter conditions.

Finally, the discomfort of working in and about freezing water has retarded winter investigations. The usual rush to complete reports, correspondence and laboratory experiments has provided those workers free to engage in winter field work with a good excuse if not the necessity for remaining in warm offices or laboratories over the cold period.

To balance inland fishery research from a seasonal standpoint, it will be necessary for the appropriate authorities:

(1) To realize the importance of winter conditions as factors controlling the game fish crop;

(2) To build up a permanent, all-year staff of able and willing research workers, rather than to rely solely on university men free only in the summer;

(3) To employ a sufficient number of investigators, with adequate technical and clerical assistants, to permit at least one trained worker to spend much of his time each winter in field work.

It is concluded that there is a real need for the continuation and extension of fisheries research in inland water; and that winter investigations may be as important as summer studies, and that they have certainly been unduly and harmfully neglected; that personnel and facilities should be provided to permit the investigation of these winter conditions which limit, or may control, the annual game fish crop.